

# **5-Year Oil Combustion Plan**

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***In partnership with:***



**BROOKHAVEN**  
NATIONAL LABORATORY

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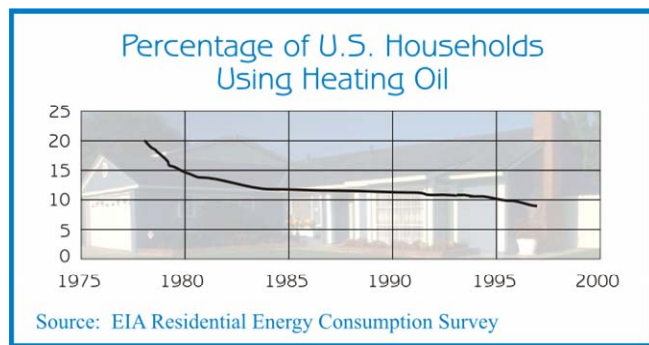
**Section 1.0**  
**Fuel Oil Past and Present**  
(from the *Oilheat Industry Roadmap-  
Toward a Sustainable Energy Future*)

# Introduction

## *Oilheat: A Fuel of Choice*

More than 10 million households in the United States are heated with oil. It is a safe, economical, clean burning, and energy-efficient fuel. For over 50 years, oil has been the primary space heating fuel for homes, businesses, and schools in both Northeastern and Central Atlantic states.

Oilheat surfaced as a primary heating fuel in the 1940's and 1950's, replacing coal furnaces, which required daily attention and maintenance. At that time, oil was seen as a modern, clean alternative to coal, which was much more difficult to store, often generated noxious fumes, and resulted in ashes and cinder which homeowners had to dispose of manually. The combination of the Gulf oil crisis of the 1970's, aggressive marketing by the natural gas industry and the public's misconception of oilheat as old-fashioned and environmentally harmful, have all led to a gradual decline in the percentage of U.S. households using oilheat.



Oilheat offers consumers a product that compares favorably with other home heating options. Modern oil burners produce negligible amounts of smoke and soot. Oil burning appliances are typically 85% efficient or higher. Homeowners and building managers receive the most value when they choose oil as a heating fuel.

Not only is oil economical, efficient and mobile, it is also a very safe heating fuel. If an oilheat tank leaks, it is non-explosive. In addition, the risk of carbon monoxide exposure from the fuel is low. When a burner goes out of adjustment, oil generally generates smoke before high levels of carbon monoxide is released, alerting a homeowner or building manager of a potential problem. By contrast, it is impossible for building owners or managers to detect a carbon monoxide leak by simply looking at a natural gas or propane burner.

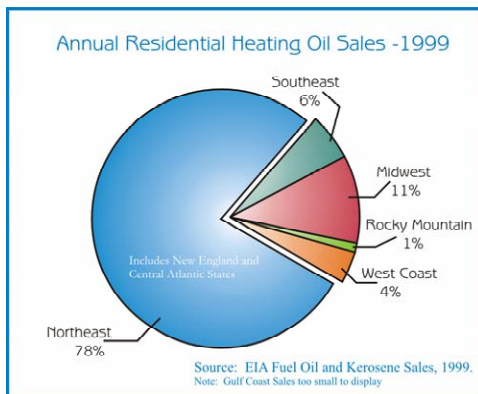
## *Oilheat's Use in the Marketplace*

Residential heating oil is a middle distillate fuel; other middle distillates include kerosene, jet fuel, and highway diesel fuel. Refiners primarily produce heating oil in the winter, when demand is the highest. They can increase production to a modest degree; production levels then reach a point at which refiners may need to produce other petroleum products, which cannot be sold in sufficient quantities during those winter months. Thus, to help meet high winter demands, refiners build inventories in the prior

summer and fall. However, if demand is high for another seasonal petroleum product, such as gasoline, refiners may delay production of heating oil, thus lowering inventories.

Refiners and importers ship heating oil by barge, tanker, rail, or pipeline into a central distribution area, such as New York Harbor, where it is then redistributed to wholesale terminal operations throughout the country. The product is then distributed by truck to local oilheat dealers for storage or sent directly to residential, commercial, and institutional consumers.

In addition to heating oil being a highly seasonal fuel, used primarily in the October to March time period, oilheated homes and buildings are primarily found in the Northeast, which includes New England and the Central Atlantic states. Of U.S. households that use oilheat, 69% are in the Northeast and account for 78% of 1999 residential heating oil sales.



The oilheat industry's unique and significant advantage over electric and natural gas is that it has access to a worldwide refining infrastructure and is easily and economically transported. For example, in the northeast transportation costs comprise 20% of oil's total cost, versus 80% for natural gas. In addition, heating oil is inexpensive to store in large wholesale terminals, helping to offset peak winter demand.

Across the country, oilheat is rarely installed in new home construction or in remodeled or renovated buildings. Eighteen percent of all new homes constructed before 1950 used oil as their main heating fuel; today that number has dropped to 4%. This is due to the fact that builders have little interest in the heating system operating costs but are very sensitive to capital costs required to heat homes. In turn, utilities offer builders cash subsidies to install natural gas or electric heating systems, and these subsidies are almost always paid by the rate payer, not the stockholders. Unfortunately, this is a state-by-state issue regulated by state public service commissions. The oilheat industry has been unsuccessful in eliminating this subsidy.

### ***The Oilheat Industry Today***

The U.S. oilheat industry employs more than 160,000 workers, most of whom are trained and highly skilled technicians in over 6,000 small, highly competitive, family-owned businesses. These small oilheat marketers, distributors, and suppliers compete for customers against local gas and electric utilities, as well as each other. Due to this highly competitive market, oilheat suppliers provide a full range of professional, in-home services exclusive to oil heat companies - an important advantage for homeowners and building managers. Oilheat industry professionals take great pride in providing superior

servicing of oilheat equipment. Whether it is the middle of the night or in below-freezing temperatures, servicemen are always available to diagnose and fix problems. Building on this customer service philosophy, the oilheat industry is striving to maintain and build their market share, as well as move into new niche markets.

The U.S. Department of Energy (DOE), in cooperation with oilheat marketers and equipment manufacturers, has, in past years supported improvements in the efficiency and technology of oil heating equipment. This cooperative relationship has led to tremendous advancements in the efficiency of oilheat equipment, saving consumers over \$6 billion and resulting in savings of \$500 for each \$1 invested in research and development.

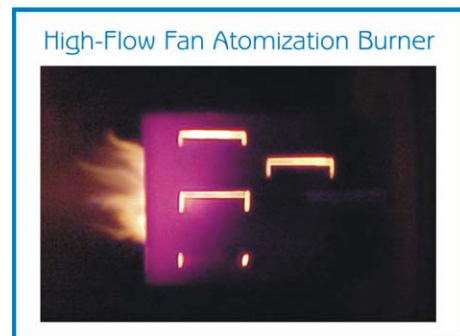
In 2000, Congress recognized the need for increased research, development and demonstration (RD&D), by passing the National Oilheat Research Alliance (NORA) Act of 2000, which created a national check-off program for the oilheat industry. Such check-off programs are voluntary, initiated and run by the industries that fund them. Implementing regulations are self-imposed and administered by members of the industry. Among the anticipated programs to be initiated with the oilheat funds, is collaborative research on oilheat technology enhancements, such as production of “clean oil” through the removal of sulfur and reduction of nitrogen, and improved transportation and storage. NORA and the Petroleum Marketers Association of America (PMAA) are facilitating a working relationship with leaders of the oilheat industry to enhance education and communication activities, and improve the public's perception of oilheat.

### ***Forces Driving the Industry***

Many factors will determine the future of oilheat in the U.S. over the next twenty years — technological change, market forces, customer needs, environmental pressures, and regulatory and institutional issues.

#### **Technological Change**

**New energy technologies** are playing an important role in determining the future of the oilheat industry. Low NOx burners (<50 ppm) allow oilheat to be as clean a heating option as any available and provide high equipment reliability. Two-stage burners improve efficiency, reduce cycling rates, and prolong the life of the oilheat system. Clean oil combustion technologies, such as the Fan Atomized Burner, are being developed to meet future environmental regulations and allow for integration of oilheat into total energy systems - heating, cooling, and power.



**Information technologies** are critical to all aspects of business. Smart technologies allow oilheat suppliers to manage their customers' heating systems more effectively. Many hours are already spent by technicians in diagnosing problems, but

self-diagnostic equipment could be used to identify problems and cut back on service times. Flame quality monitors are being developed to notify customers when burners have to be serviced, instead of waiting for the system to fail.

In the future, **technologies that supply heat as a byproduct of power** will help oilheat penetrate the buildings, cooling, heating, and power (BCHP) market. Oilheat thus will grow not only within the CHP market, but will help reach the CHP Challenge goal of 96 GW by the year 2010.

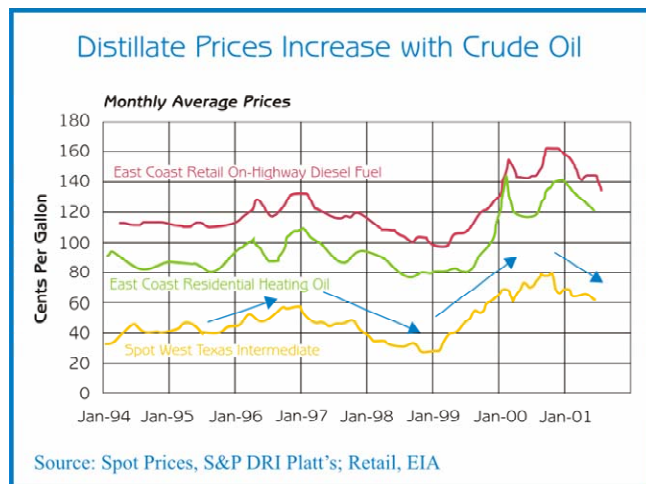
**Improved tank technology** will allow systems to be more environmentally friendly. Customers will not be concerned about tank leaks and environmental and economic impacts associated with them. Tanks will reduce fuel contamination, be appropriately sized, visually pleasing to the homeowner or building manager, and will maintain efficient fuel delivery.

**Poor fuel performance** accounts for up to one-half of service calls. Additives can improve fuel performance characteristics and prevent accumulation of contaminants within fuel tanks. Additive research can improve choices and effectiveness.

**Biofuels** blended with distillate oil can provide a complete or partial substitute for oilheat when supplies are low. Biofuel is manufactured from vegetable oils, cooking grease, or animal fats and can be used in combination with distillate oil or as a pure renewable fuel. Many states offer tax credits for the use of renewable fuels. Currently biofuel is not exempt from federal and state taxes, but in the future biofuels may be recognized as a “renewable fuel” and become eligible for tax incentives. The low sulfur content of biofuels will certainly meet future environmental regulations.

## Market Forces

**The price of crude oil on the world market drives** the price of heating oil. The cost of heating oil, compared to competitive fuels (e.g., natural gas, propane, electricity), drives its use in the marketplace. In areas of the U.S. where electricity and natural gas are transported short distances from the source of supply, they are preferred heating fuels.



Electric baseboard systems usually have lower installed capital costs than oilheat systems, even though they are less energy efficient.

Although the residential sector is the primary market for oilheat, **the commercial sector**, which accounts for 36% of U.S. total energy consumption, presents a huge opportunity for oilheat. Forty-six percent (46%) of the U.S.'s electricity is consumed in the

commercial energy space and water heating market. Currently, only 4% of commercial buildings nationwide use fuel oil for space and water heating, presenting a large market opportunity for this fuel.

### **Environmental Pressures**

**Air quality emission regulations** for sulfur and NO<sub>x</sub> are becoming increasingly stringent. In past years, the oilheat industry has been able to respond to environmental requirements for limiting sulfur and NO<sub>x</sub>. With new, cleaner oil burning technologies, oilheat should be able to respond again.

**Underground tank leaks** can become very costly to homeowners and building managers. Fortunately, many states have pollution funds, which cover all, or part of pollution from tank leaks; private insurance is also available for around \$100 per tank.

### **Regulatory and Institutional Constraints**

**Oilheat's image** stands in the way of improvements in market share. This image, an often negative one, results from lack of education. Consumers switch from oilheat to natural gas, for no other reason than their perception that natural gas is less expensive and cleaner; in reality, converting to gas or electricity does not make economic or environmental sense. From an environmental perspective, it is better to conserve a BTU of oil by replacing old equipment or improving energy efficiency, than to replace the system with a BTU of gas.

Consumers need to be educated about oilheat's cost effectiveness and environmental friendliness. Residential and commercial/institutional builders need better information and technical assistance on oilheat system design and installation. **A comprehensive marketing and education program** will help shed oilheat's negative image and improve the environment for attracting industry workers.

**Federal and state transportation regulations** specify the number of hours oilheat drivers may spend on the road. This has had a negative impact on the industry. Just recently, however, the U.S. Department of Transportation approved the Oilheat Delivery of Hours of Service Program. This program grants commercial motor vehicle drivers an exemption from hours-of-service restrictions when making winter home heating oil deliveries within a 100 air-mile radius of a central terminal or distribution point.

**Fuel quality specifications** will play a role in oilheat's future. Low sulfur fuel oil is beginning to gain favor as a home heating fuel. Current residential heating oil has an average sulfur value of 0.25%. Studies have shown that sulfur emissions lead to fouling of heating oil equipment, lowering system efficiency and increasing the need for frequent equipment cleaning. Low sulfur (0.05%) fuel oil is currently used in highway transportation; it can lower service costs and maintain oilheat system efficiency.

**The heating industry is seasonal.** Oilheat distributors respond to market demand by lowering their prices, affecting profitability. By contrast, the price of natural gas and electricity is allowed by state regulatory policies, to remain high during similar periods of low demand. This situation creates an unfair advantage for natural gas and electric utilities.

### ***Background and Structure of the Oilheat Vision and Roadmap***

In August of 2001, key representatives of the oilheat industry met with researchers and government officials at Brookhaven National Laboratory for the National Oilheat Industry Vision Workshop. This Workshop resulted in the publication of the National Oilheat Vision, which, in broad terms, outlines a vision for the oilheat industry and strategic goals that need to be addressed in achieving it.

Following the Vision Workshop, a National Oilheat Industry Roadmap Workshop was held on November 13-14, 2001, at the University of Maryland, College Park, Maryland. This meeting involved many of the same stakeholders as the Vision Workshop, and others as well, who creatively looked at solutions to technical, institutional, and market barriers facing the industry. Participants refined the vision and strategic goals, identified barriers that threaten the growth of the industry, and developed actions to overcome the barriers.

This roadmap, *The Oilheat Industry Roadmap—Toward a Sustainable Energy Future*, is a result of their deliberations. It consists of three main action areas:

- **Improving fuel quality and performance**
- **Enhancing equipment and service**
- **Expanding markets and applications**

**Section 2.0**  
**Five Year Oil Combustion Activity**  
**Plan**

## 2.0 Five Year Oil Combustion Plan

### 2.1 Introduction

The Distributed Energy and Electric Reliability (DEER) Program within the U.S. Department of Energy (DOE) is working in partnership with the Petroleum Marketers Association of America (PMAA), the newly formed National Oilheat Research Alliance (NORA), and Brookhaven National Laboratory (BNL) to ensure a safe, reliable and clean energy future for the United States through a diversified fuel mix that includes fuel oil as a major component. Together, this partnership has created an industry vision and technology roadmap for research, development, and commercialization of new oil combustion products and systems. The recently published *Oilheat Industry Roadmap-Toward a Sustainable Energy Future*, identifies technical, policy, and market challenges for the oilheat industry and outlines opportunities for strategic public and private partnerships that will address these challenges through specific actions.

Fuel oil is an important component of America's energy supply, used for power generation, cooling, space and water heating, and indoor air comfort for residential, commercial, and light industrial buildings. The oilheat industry is poised to take a major step forward in maintaining its market share in these end use sectors and making oil a fuel of choice. The *Oilheat Industry Roadmap* proposes specific actions in three areas:

- Improving Fuel Quality and Performance
- Enhancing Equipment and Service
- Expanding Markets and Applications

DOE proposes to assist industry in successfully executing the actions established in the Roadmap and achieving the industry's vision of its future. This vision is as follows:

*The Oilheat Industry will be a customer-driven supplier of premium indoor comfort. Oilheat will be a consumer fuel of choice – affordable, environmentally friendly, and offering total energy solutions for on-site space heating and cooling, hot water, and power. By capitalizing on its already strong infrastructure, the industry will provide worry-free, self-sufficient, virtually invisible energy systems to its customers. The oilheat industry will regain its commercial and institutional customers and expand its residential market. New niche markets will be developed, to capture a substantial portion of not only the heating market, but also the total energy market by the year 2020.*

This plan presents DOE's activities for the next five years. These activities will provide valuable assistance to the oil combustion industry as well as to appropriate state organizations in addressing the technical challenges identified by the Roadmap which offer the greatest potential for improving energy efficiency and reducing environmental impacts of oil combustion and use. NORA and the New York State Energy Research and Development Authority (NYSERDA) are addressing technical challenges as well; DOE adds considerable expertise and leadership to their efforts by offering highly

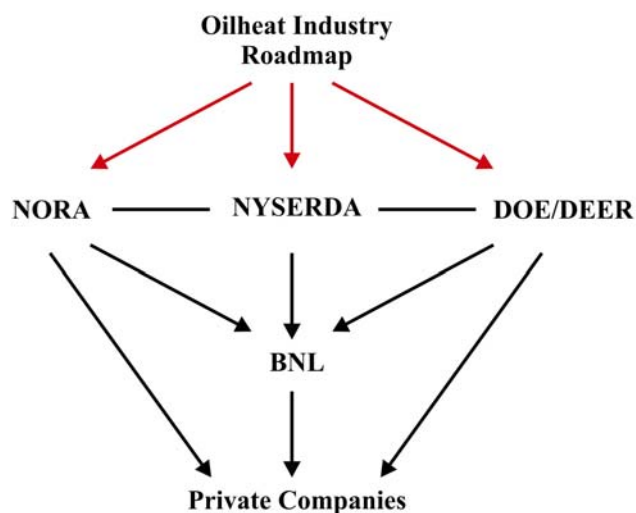
knowledgeable personnel and state-of-the-art research and development facilities at Brookhaven National Laboratory.

Thus, to achieve the Roadmap vision, DOE and its industry, national laboratory, and state agency partners have outlined the following specific goals:

- NO<sub>x</sub> emission rates of under 20ppm
- Improved burner technologies which are energy efficient and better matched with heating requirements in buildings.
- Self-diagnostic and self-adjusting control technologies that will provide industry with state-of-the-art service tools and lead to 2-3 year service intervals
- Development of high performance packaged systems for electric-to-oil conversions.
- Building Cooling, Heating, and Power (BCHP) systems that utilize fuel oil

The structure of the program will include basic support provided to our National Laboratories, as well as competitively bid research, development, and demonstration projects. Private and public organizations may also participate through cost shared agreements on specific projects. NORA is following DOE's lead by using the Roadmap as a guide to developing and managing research and development activities. This cooperative RD&D program is illustrated below; program activities are being undertaken by DOE/DEER, Brookhaven National Laboratory, NORA, and the New York State Energy Research and Development Authority (NYSERDA). Private industry R&D is supported with funding from DOE, NORA, BNL, and NYSERDA, as well as other state energy offices.. The *Oilheat Industry Roadmap* serves as the guide for all of this work. The exhibit below illustrates this cooperative working relationship.

**Exhibit 1. Oil Combustion Research and Development Participants**



## **2.2 Research and Development Activities**

The following specific research and development activities are designed to implement the actions presented in the *Oilheat Industry Roadmap*. The actions address goals and objectives in three areas:

- **Improving Fuel Quality and Performance**
- **Enhancing Equipment and Service**
- **Expanding Markets and Applications**

Specific actions and sub-actions for each of the activities are presented in **Section 2.0, Time Line and Milestones**.

### **Improving Fuel Quality and Performance**

**1.1 Impacts of Sulfur.** The benefits of a low-sulfur fuel are already known among equipment manufacturers and many dealers. By completing the ongoing assessment of the effects of different sulfur levels on condensing systems and cumulating all data regarding sulfur in fuel in a useable report, DOE will assist the industry in showing the benefits of a low sulfur fuel. This report will consist of reliable data that shows the impact of sulfur levels on equipment performance and emission levels.

**1.2 Fuel Performance Improvement.** This would consist of laboratory research to identify techniques to improve fuel performance and a pilot field study. In the field, a team would collect data on failure rates, additive performance, and storage management techniques. The data would be used to create a database of the different variables and how they relate to the number of failures. The combination of the laboratory research and the field study would result in highly effective fuel maintenance techniques.

#### **1.3 Premium Fuel Specification (NORA Activity)**

**1.4 Biofuel Development.** Topics of investigation include cold storage, biodiesel and oilheat blends for maximum fuel efficiency, and identification of equipment problems related to biofuel use.

### **Enhancing Equipment and Service**

**2.1 Advanced Combustion Research.** The research will expand the knowledge base for ultra-low NOX technologies, such as vaporizing technologies and the high flow atomization burner concepts. This will result in new ideas on how to reduce NOx and possible revolutionary changes to the combustion process.

**2.2 Residential and Light Commercial Low NOx Equipment.** A team will develop a low NOx system for residential and light commercial heating systems. NOx reductions would be made at the burner as well as other equipment such as boilers and

**2.3 Modulating Small Burner Concepts.** Modulating burner concepts have provided energy savings at the large commercial/industrial level, but have not been developed for smaller, primarily residential, applications. Residential heating systems often operate at inefficient capacities, producing too much heat than needed, and this is one of the areas that would provide the biggest improvement for the already high system efficiency. A team would develop a small modulating burner and control schemes for a typical residential heating system.

**2.4 Sensors and Diagnostic Tools Research.** The sensors and controls will be able to detect degradation in the flame quality, notifying the homeowner and dealer, when the equipment needs to be serviced. These tools will possibly be able to detect where the problem is located (nozzle, fuel quality, etc) to save the technician the time it takes to diagnose and fix the problem.

**2.5 Self-Adjusting Commercial Burners.** A team will research and develop state-of-the-art commercial burners that are able to self-adjust to different conditions, reducing the need for service calls and service costs.

### **Expanding Markets and Applications**

**3.1 Field Study of Use Patterns.** The field study would consist of collecting and analyzing data from residential homes on heating uses. The patterns can be used to identify algorithms for control schemes, as well as identifying the efficiency of heating oil use.

**3.2 Oil-fired Low NOx Integrated Energy Systems.** Teams would develop modular oil-fired, low NOX integrated energy systems. These systems would consist of a prime mover to generate electricity and heating and cooling equipment that capture the rejected heat to support room conditioning loads in light commercial and residential applications.

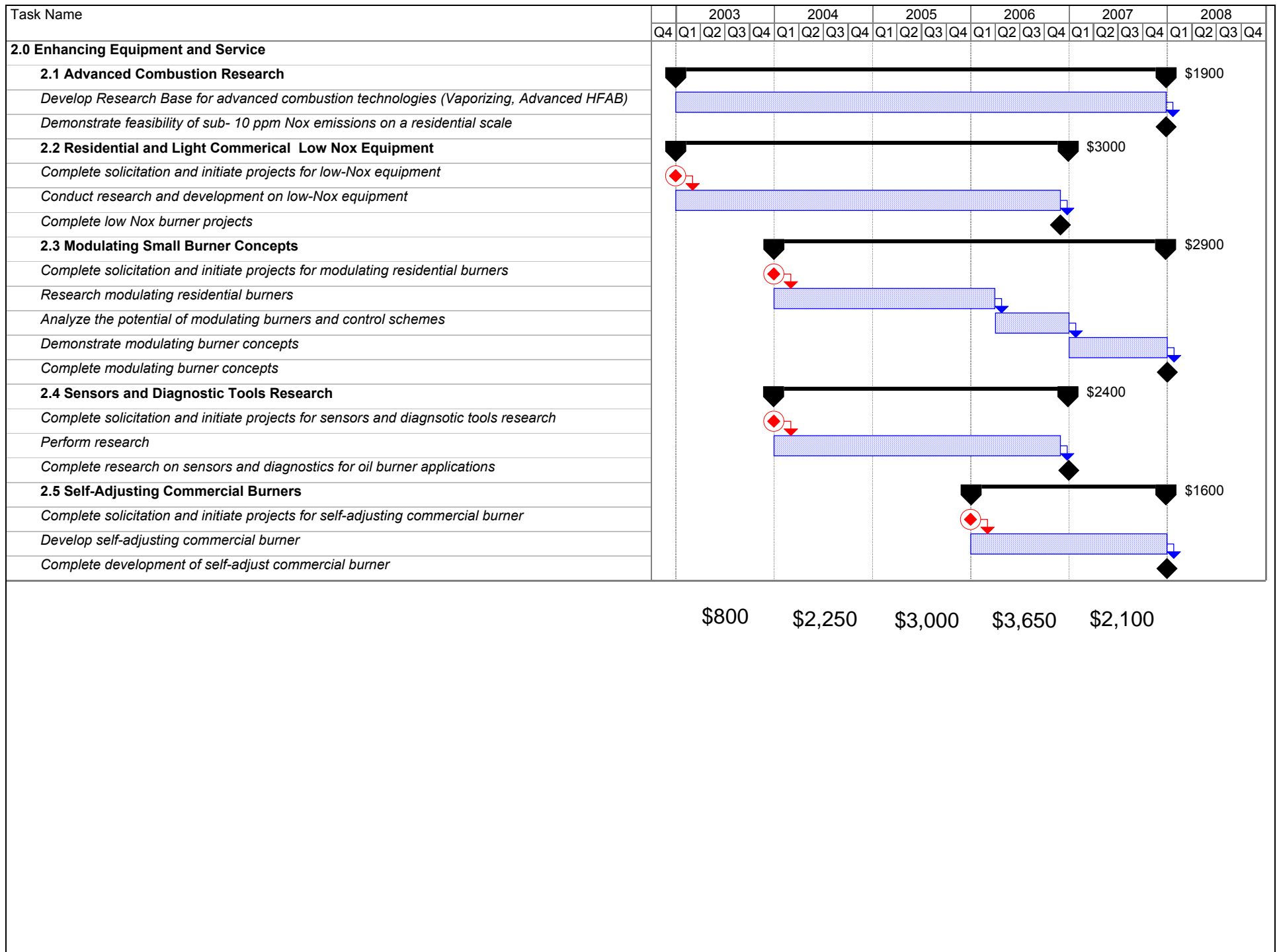
**3.3 Venting Guidelines.** The venting guidelines will help dealers and builders to install oilheat systems that are vented properly and efficiently.

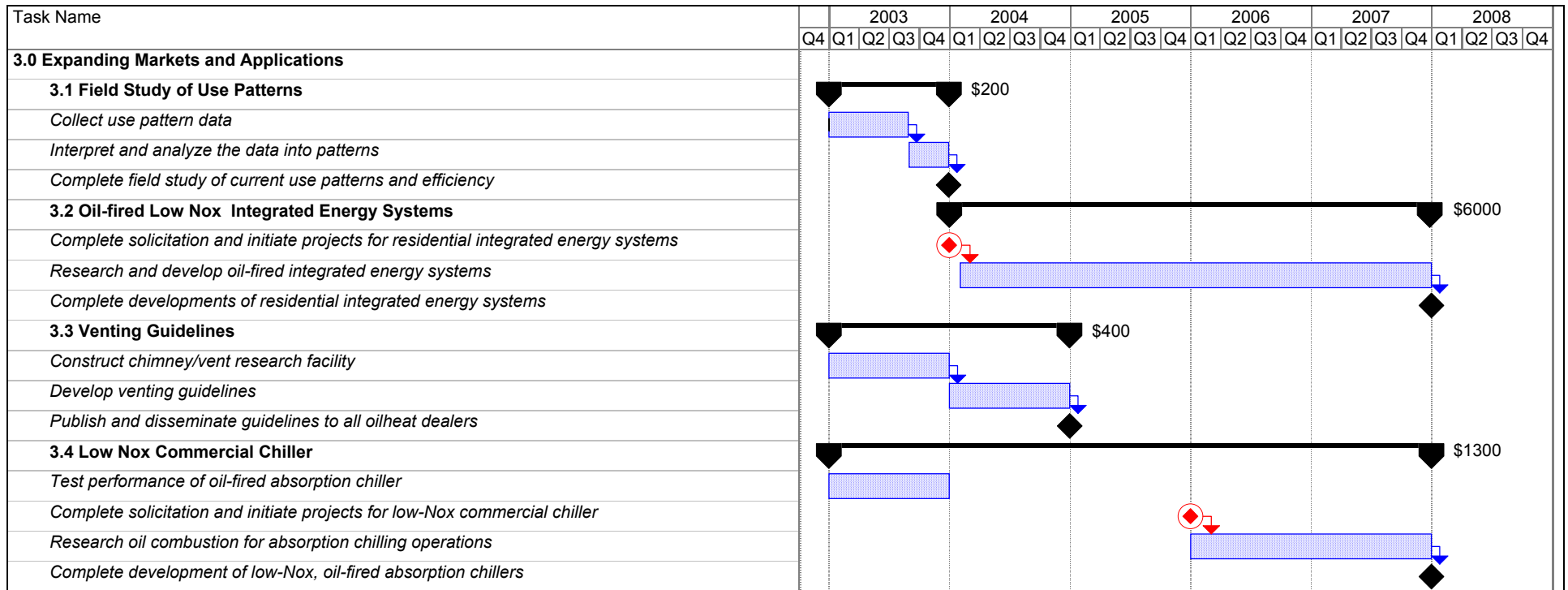
**3.4 Oil-fired Low NOx Commercial Chiller.** A low-NOx commercial chiller will allow oil to support cooling loads as well as heating loads. Oil-fired chillers will offer a clean, on-site alternative cooling source.

## **Section 3.0**

### **Time Line and Milestones**







\$600      \$500      \$2,000      \$2,600      \$2,200

**Section 4.0**  
**Oil Combustion Activity Plan Budget**  
**Projections**

Activity	DOE Activity Budget (\$ 000)					<u>5-yr Total</u>
	<u>FY 03</u>	<u>FY 04</u>	<u>FY 05</u>	<u>FY 06</u>	<u>FY 07</u>	
<b>1.0 Improving Fuel Quality and Performance</b>	<b>\$240</b>	<b>\$250</b>	<b>\$600</b>	<b>\$250</b>	<b>\$250</b>	<b>\$1,590</b>
1.1 Impacts of Sulfur	\$60					\$60
1.2 Fuel Performance Improvement	\$130	\$200	\$200			\$530
1.3 Premium Fuel Specification (NORA Activity)						
1.4 Biofuel Development	\$50	\$50	\$400	\$250	\$250	\$1,000
	<u><b>FY 03</b></u>	<u><b>FY 04</b></u>	<u><b>FY 05</b></u>	<u><b>FY 06</b></u>	<u><b>FY 07</b></u>	<u><b>5-yr Total</b></u>
<b>2.0 Enhancing Equipment and Service</b>	<b>\$800</b>	<b>\$2,250</b>	<b>\$3,000</b>	<b>\$3,650</b>	<b>\$2,100</b>	<b>\$11,800</b>
2.1 Combustion Research	\$200	\$300	\$400	\$500	\$500	\$1,900
2.2 Residential and Light Commercial Low Nox Equipment	\$600	\$650	\$1,000	\$750		\$3,000
2.3 Modulating Small Burner Concepts		\$500	\$800	\$800	\$800	\$2,900
2.4 Sensors Research and Diagnostic Tools		\$800	\$800	\$800		\$2,400
2.5 Self-Adjusting Commercial Burners				\$800	\$800	\$1,600
	<u><b>FY 03</b></u>	<u><b>FY 04</b></u>	<u><b>FY 05</b></u>	<u><b>FY 06</b></u>	<u><b>FY 07</b></u>	<u><b>5-yr Total</b></u>
<b>3.0 Expanding Markets and Applications</b>	<b>\$600</b>	<b>\$500</b>	<b>\$2,000</b>	<b>\$2,600</b>	<b>\$2,200</b>	<b>\$7,900</b>
3.1 Field Study of Use Patterns	\$200					\$200
3.2 Oil-fired Integrated Energy Systems		\$400	\$2,000	\$2,000	\$1,600	\$6,000
3.3 Venting Guidelines	\$300	\$100				\$400
3.4 Low Nox Commercial Chiller	\$100			\$600	\$600	\$1,300
<b>Total Cost for each Year</b>	<b>\$1,640</b>	<b>\$3,000</b>	<b>\$5,600</b>	<b>\$6,500</b>	<b>\$4,550</b>	<b>\$21,290</b>